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Effect of sodium hydrogen carbonate ($NaHCO_3$) on heat stress reduction of broiler chicken fed high energy diet

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ABSTRACT

Effect of sodium hydrogen carbonate ($NaHCO_3$) administration on broiler chicken fed high energy diet were investigated in an experiment with 48 broiler birds within the last 4 weeks of the experiment. The study which lasted for 8weeks commenced with day old chicks and were fed commercial starter feed for the first 4weeks after which three different experimental diets were formulated.. Birds were randomly assigned to the three treatment groups, each treatment consisting of 16 birds with 4 replicates of 4 birds per replicate. Treatments groups are the control (T1) energy diet of 2900kcal, (T2) energy diet of 3300kcal and (T3) energy diet of 3300kcal with the addition of $NaHCO_3$. At 5 weeks, the hematological mean values across the treatment group showed the RBC($x10^{12}$/l) of diet 3(2.71) was significantly ($p<0.05$) higher than Diet 1(2.12) and Diet 2(2.55). MCV(μ^3) results were significantly different from each other with Diet 1 having the highest value. MCHC (%) of Diet 1 was significantly ($p<0.05$) higher than the other groups. WBC ($x10^6$/l) of Diet 2 was significantly ($p<0.05$) higher than the other treatment groups. At 6 weeks MCV(μ^3), MCH(µµg) and MCHC (%) of Diet 3 were significantly ($p<0.05$) higher compared to the other diet groups. WBC ($x10^6$/l) of Diet 2 was significantly ($p<0.05$) higher than other groups. At 8 weeks PCV (%), hemoglobin (g/dl), heterophils (%) and eosinophils (%) of Diet 3 were significantly ($p<0.05$) higher compared to the results of the other treatment groups. WBC($x10^6$/l) was highest in Diet 1(29.90). At 8 weeks, mean values of organ weight(g) and crop Ph revealed that the weight of the Adrenal gland and liver were significantly ($p<0.05$) higher in Diet 1 compared to other groups while the weight of the heart was significantly ($p<0.05$) higher in both Diets 1 and 2 compared to those fed Diet 3. Crop Ph was higher (6.72) in Diet 3 compared to Diet 1 (6.15) and Diet 2 (6.36) both of which were not significantly different from each other. The results of the performance values at 8 weeks showed that live weight (kg) and dressed weight (kg) across the treatment groups were not significantly different but abdominal fat (g) was significantly ($p<0.05$) higher in Diet 1(38.18) compared to diet 2 (30.74) and Diet 3 (31.20). In conclusion, increase in feed energy plus inclusion of $NaHCO_3$ in the diet influenced crop pH, PCV RBC and WBC values.

Keywords: Broiler; sodium hydrogen carbonate ($NaHCO_3$); heat stress; Diet

INTRODUCTION

Animal health depends on many factors and recently it has been appreciated that diet plays a pivotal role in health maintenance and prevention of various diseases. High ambient temperatures can be devastating to commercial broilers, coupled with high humidity they can have an even more harmful effect. Heat stress results from a negative balance between the net amount of energy flowing from the animal's body to its surrounding environment and the amount of heat energy produced by the animal. This imbalance may be caused by variations of a combination of environmental factors (e.g., sunlight, thermal irradiation, and air temperature, humidity and movement), and characteristics of the animal (e.g., species, metabolism rate, and thermoregulatory

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mechanisms). Environmental stressors, such as heat stress, are particularly detrimental to animal agriculture [1]. The importance of animal responses to environmental challenges applies to all species.

However, poultry seems to be particularly sensitive to temperature-associated environmental challenges, especially heat stress. It has been suggested that modern poultry genotypes produce more body heat, due to their greater metabolic activity [2]). Understanding and controlling environmental conditions is crucial to successful poultry production and welfare. In animal production, several studies have investigated the effects of heat stress on the immune response in recent years [3;4;5]. The immunosuppressing effect of heat stress on broilers and laying hens have been investigated in several studies, although using different measurements. For instance, lower relative weights of thymus and spleen has been found in laying hens subjected to heat stress [6] reduced lymphoid organ weights have also been reported in broilers under heat stress conditions [7]. During heat stress sever enough to induce a high respiratory rate (sever panting, rapid, shallow breathing) and rectal temperature, abnormally high amounts of carbon dioxide (CO_2) are lost from the blood (partial pressure of CO_2 or pCO_2, decreases), blood HCO_3 declines and pH decreases over about a two hour period [8], therefore, the objective of this study is to investigate the influence of sodium bicarbonate (a salt) in combating heat stress of broiler chicken in hot humid tropical environment.

MATERIALS AND METHODS

The experiment was conducted using 60 broiler chickens in the teaching and research farm of the federal university of technology Owerri, Nigeria between the months of February and April. The study which lasted for 8 weeks commenced with day old chicks and were fed commercial starter feed for the first 4weeks after which three different experimental diets were established. Birds were randomly assigned to the three treatment groups, each treatment consisting of 20 birds with 4 replicates of 5 birds per replicate. Treatments groups are the control (T1) energy diet of 2900kcal, (T2) energy diet of 3300kcal and (T3) energy diet of 3300kcal with the addition of $NaHCO_3$. Sodium hydrogen carbonate ($NaHCO_3$) was administered at the rate 15g in three liters of water daily. A clinical thermometer was placed in each pen to check and maintain the temperature between 28°C to 34°C.

Carcass Evaluation

At the end of the experiment, birds were weighed. Diet and water were withdrawn from the broiler chickens 12hours before being slaughtered. A total of 10 birds were slaughtered per treatment. The birds were weighed just before slaughtering, and after slaughtering using the mechanical dial spring weighing scale. The carcass was opened and the organs (heart, spleen, kidney liver, adrenal gland, abdominal fat) were weighed using Mettler digital analytical balance. Crop pH was also ascertained using Portable pH tester. The carcass was weighed without the internal organs after de-feathering with hot water (dressed weight). All values were recorded.

Hematological Analysis

At the end of the trial, 10 birds were randomly selected per treatment and bled through the jugular vein. Five (5ml) of blood samples were collected and emptied into Ethylene Diamine Tetra Acetic Acid (EDTA) bottle, for haematological evaluation. Packed cell volume

(PCV), Haemoglobin (Hb), Red Blood cell (RBC), White blood cell (WBC), Lymphocytes , Neutrophils, Monocytes, and Eosinophils were analysed. RBC, PVC and Hb were analysed as described by Lamberg and Rothstein [9]. WBC was analysed using Neubauer chamber haemocytometer. Mean corpuscular volume (MVC), Mean corpuscular hemoglobin(MCH) and Mean corpuscular hemoglobin concentration (MCHC) were calculated using the following formulas:

$$MCV = \frac{PCV}{RBC} \times 10,$$

$$MCH = \frac{HB}{RBC} \times 10, \quad MCHC = \frac{HB}{PVC} \times 10$$

Crop pH was analysed using a Portable pH tester (Fisher scientific accumet AP110 pH meter kit)

Experimental Diet

Table 1: Composition of Experimental Diets

Ingredients (%)	T1(energy diet of 2900kcal) Cp= 21%	T2 (energy diet of 3300kcal) Cp = 22.5%	T3 (energy diet of 3300kcal + $NaHCO_3$) Cp = 22.5%
Maize	50	50	50
Full fat soya	26	26	26
Fish meal	4	4	4
Wheat offal	4	2	2
Bone meal	2	2	2
Oyster shell	1	1	1
Broiler premix	0.25	0.25	0.25
Salt	0.25	0.25	0.25
Lysine	0.25	0.25	0.25
Methionine	0.25	0.25	0.25
Palmoil	2	4	4
Analysis Calculated			
CP (%)	20.85	22.61	22.61
MEKcal/kg	2898	3384	3384

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Statistical Analysis

Data were analysed using the one way ANOVA of SAS, [10] procedure and Duncan multiple range test option of the same statistical software was used to separate the treatment means.

RESULTS

Table 2 shows the hematological mean values of broiler fed diet 1 (2900kcal), diet 2 (3300kcal), and 3300kcal diet + sodium hydrogen carbonate ($NaHCO_3$) [diet 3] at 5 weeks. At 5 weeks, the hematological mean values across the treatment group showed the RBC($x10^{12}/l$) of diet 3(2.71) was significantly ($p<0.05$) higher than Diet 1(2.12) and Diet 2(2.55). MCV(μ^3) results were significantly different from each other with Diet1 having the highest value. MCH (%) of Diet 1 was significantly ($p<0.05$) higher than the other groups. WBC ($x10^6/l$) of Diet2 was significantly ($p<0.05$) higher than the other treatment groups.

Table 3 shows the Hematological mean values of broiler fed 2900kcal diet (diet 1), 3300kcal diet (diet 2), and 3300kcal diet + sodium hydrogen carbonate ($NaHCO_3$) [diet 3] at 6 weeks. At 6weeks MCV(μ^3), MCH(μμg) and MCHC (%) of Diet3 were significantly ($p<0.05$) higher compared to the other diet groups. WBC ($x10^6/l$) of Diet 2 was significantly ($p<0.05$) higher than other groups.

Table 4 shows the Hematological mean values of broiler fed 2900kcal diet (diet 1), 3300kcal diet (diet 2), and 3300kcal diet + sodium hydrogen carbonate ($NaHCO_3$) [diet 3] at 8 weeks. At 8 weeks PCV (%) was not significantly different across treatment groups, hemoglobin (g/dl), heterophils (%) and eosinophils (%) of Diet 3 were significantly ($p<0.05$) higher compared to the results of the other treatment groups. WBC($x10^6/l$) was highest in Diet 1(29.90). Lymphocytes (%) was significantly higher in Diet 2 (70.75) compared to the diet 1(62.65) and diet 3(49.25).

Table 5 shows the performance values of live weight, dressed weight, and abdominal fat of broiler fed 2900kcal diet (diet 1), 3300kcal diet (diet 2), and 3300kcal diet + sodium hydrogen carbonate ($NaHCO_3$) [diet 3] at 8 weeks. The results of the performance values at 8 weeks showed that live weight (kg) and dressed weight (kg) across the treatment groups were not significantly different but abdominal fat (g) was significantly ($p<0.05$) higher in Diet 1(38.18) compared to diet 2 (30.74) and Diet 3 (31.20).

Table 6 shows the mean values of organ weight and crop pH of broilers fed 2900kcal diet (diet 1), 3300kcal diet (diet 2), and 3300kcal diet + sodium hydrogen carbonate ($NaHCO_3$) [diet 3] at 8 weeks. The results show reduction in size of adrenal gland in diets 2 and 3 (0.18 and 0.16, respectively heart and liver sizes were highest in the control group compared to diets 2 and 3). Crop pH was raised close to neutral in diet 3 which were acidic in diet 1 and 2.

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Table 2: Hematological mean values of broiler fed 2900kcal diet (diet 1), 3300kcal diet (diet 2), and 3300kcal diet + sodium hydrogen carbonate ($NaHCO_3$) [diet 3] at 5 weeks

Parameters	Diet 1	Diet 2	Diet 3	±SEM
PCV (%)	24.17	23.00	23.33	0.45
Hemoglobin (g/dl)	8.18	7.67	7.77	0.14
RBC ($x10^{12}$/l)	2.12^{ab}	2.55^{b}	2.71^{a}	0.12
MCV(μ^3)	124.87^{a}	91.63^{b}	86.11^{ab}	7.30
MCH(μμg)	41.70^{a}	30.55^{b}	28.67^{b}	2.43
MCHC (%)	33.38	33.37	33.29	0.03
WBC ($x10^{6}$/l)	13.38^{b}	15.69^{a}	10.33^{ab}	0.78

SEM= Standard error of mean, and a,b= means in the same row with different superscripts differ significantly ($p<0.05$) from each other.

Table 3: Hematological mean values of broiler fed 2900kcal diet (diet 1), 3300kcal diet (diet 2), and 3300kcal diet + sodium hydrogen carbonate ($NaHCO_3$) [diet 3] at 6 weeks.

Parameters	Diet 1	Diet 2	Diet 3	±SEM
PCV (%)	28.67	30.33	29.83	0.44
Hemoglobin (g/dl)	9.53	10.08	9.97	0.14
RBC ($x10^{12}$/l)	2.84	3.00	2.02	0.22
MCV(μ^3)	110.69^{b}	121.53^{b}	154.90^{a}	11.51
MCH(μμg)	36.80^{b}	40.40^{b}	51.74^{a}	3.82
MCHC (%)	33.26^{b}	33.24^{b}	33.41^{a}	0.03
WBC ($x10^{6}$/l)	14.42^{b}	16.23^{a}	11.13^{ab}	0.76

SEM= Standard error of mean, and a,b= means in the same row with different superscripts differ significantly ($p<0.05$) from each other.

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Table 4: Hematological mean values of broiler fed 2900kcal diet (diet 1), 3300kcal diet (diet 2), and 3300kcal diet + sodium hydrogen carbonate ($NaHCO_3$) [diet 3] at 8 weeks.

Parameters	Diet 1	Diet 2	Diet 3	±SEM
PCV (%)	25.25	27.00	28.75	0.56
Hemoglobin (g/dl)	8.40^{b}	9.00^{a}	9.58^{a}	0.19
RBC ($x10^{12}$/l)	2.80	2.92	3.12	0.13
MCV(μ^3)	94.96	92.66	96.11	4.77
MCH(μμg)	31.57	30.89	31.14	1.49
MCHC (%)	33.28	33.34	33.31	0.03
WBC ($x10^{6}$/l)	29.90^{a}	24.86^{b}	24.91^{b}	1.65
Lymphocytes (%)	62.65^{b}	70.75^{a}	49.25^{c}	3.84
Heterophils(%)	31.50^{b}	21.00^{c}	43.25^{a}	3.46
Monocytes (%)	1.50	2.25	2.25	0.49
Eosinophils (%)	4.75^{b}	3.50^{c}	6.25^{a}	0.54

SEM= Standard error of mean, and a, b, c= means in the same row with different superscripts differ significantly ($p<0.05$) from each other.

Table 5: Performance values of live weight, dressed weight, and abdominal fat of broiler fed 2900kcal diet (diet 1), 3300kcal diet (diet 2), and 3300kcal diet + sodium hydrogen carbonate ($NaHCO_3$) [diet 3] at 8 weeks.

Parameters	Diet 1	Diet 2	Diet 3	±SEM
Live weight (kg)	2.54	2.54	2.51	0.05
Dressed weight (kg)	1.89	1.91	1.84	0.04
Abdominal fat (g)	38.18^{a}	30.74^{b}	31.20^{b}	2.26

SEM= Standard error of mean, and a, b, c= means in the same row with different superscripts differ significantly ($p<0.05$) from each other.

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Table 6: Mean values of organ weight (g) and crop pH of broilers fed 2900kcal diet (diet 1), 3300kcal diet (diet 2), and 3300kcal diet + sodium hydrogen carbonate ($NaHCO_3$) [diet 3] at 8 weeks.

Parameters	Diet 1	Diet 2	Diet 3	SEM
Adrenal gland	0.33^{a}	0.18^{b}	0.16^{b}	0.05
Kidney	14.34	15.05	15.24	0.38
Spleen	2.62	2.43	2.24	0.25
Heart	12.74^{a}	12.10^{a}	11.28^{b}	0.40
Liver	50.57^{a}	46.02^{ab}	41.86^{b}	1.69
Crop pH	6.15^{b}	6.36^{b}	6.72^{a}	0.16

SEM= Standard error of mean, and a, b, c= means in the same row with different superscripts differ significantly ($p<0.05$) from each other.

DISCUSSIONS

Dietary $NaHCO_3$ has been widely used in cob breeders and in hy-line white leghorn breeders to improve litter quality, egg shell quality especially in hot weather and consistency in egg production and to keep Na assays more consistent and closer target levels by using 2 Na sources $NaHCO_3$ and NaCl [11]. The result of the PCV between the 5th and 6th weeks showed an increasing trend among the diets, although, the PCV dropped at the 8th week, diet 2 and diet 3 (higher energy diets) had higher values than diet 1. This trend was also observed in hemoglobin levels. Such fluctuation has also been reported by Mirsalimi and Julian [12] on the effect of excess sodium bicarbonate on the blood volume and erythrocyte deformability of broiler chicken. Also Srikandakumar and Johnson [4] reported that high PCV value could be an adaptive mechanism to provide water necessary for evaporative cooling process during heat stress, they also explained that reduction of Hb and PCV levels could be as a result of RBC lysis either by increased attack of free radicals on its membrane or inadequate nutrient availability for Hb synthesis as the animal consumes less feed or decreases voluntary feed intake upon heat stress. Although slight differences were observed in RBC and Hb values for diet 3 at 5 weeks and 8 weeks respectively, the PCV, hemoglobin and RBC values of the chicken at week 5, 6, and 8 were within the normal range as recorded for hematological values of Normal chicken [13]. This result shows that $NaHCO_3$ did not negatively affect the blood level of the birds. PCV which is packed cell volume accounts for the volume of red blood cells in a measure of blood while haemoglobin is the substance in

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red blood cell capable of transporting oxygen from the lungs to the body tissues.

At 5 weeks, MCV of diet 3 (86.11) was influenced by $NaHCO_3$. Diet 2 (91.63) result revealed an influence on MCV by high energy. With increase in age (6wks) the MCV of the birds increased across treatment with diet 3 having the highest value. The result shows that in the presence of $NaHCO_3$ and high energy which is capable of inducing heat stress, that red blood cell volume can be increased. This result can be explained from the chemical reaction that happens when $NaHCO_3$ yields water and CO_2 in the presence of heat or high temperature [$2\ NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$]. When water is released from cellular surface, and oncotic pressure of the circulatory system is low the cells tend to concentrate (pack closely) thereby increasing PCV or red blood cell concentration. MCH is an estimate of the amount of hemoglobin in an average red blood cell, while MCHC is the estimate of the concentration of hemoglobin in a given no of packed red blood cell. Both measure the level of anaemic condition of the animal. As the birds increased in age between 5 and 6 weeks MCH increased in value for birds on diet 2 and diet 3. These are high energy diets and diet 3 containing $NaHCO_3$. There is paucity of information concerning this result but age seems to play much role here since at 8 weeks the results on both MCH and MCHC were not different across the treatment groups. MCHC was not affected by treatments in the 5th week but slight increase was observed in diet 3, also this result could be age dependent rather than caused by treatment.

The CO_2 produced as waste product of oxidation of sugars (carbohydrate) can be converted into bicarbonate in the body which being alkaline in nature acts as a buffering agent. The $HCO3^-$ (bicarbonate) from sodium bicarbonate acts as a buffering agent which helps in acid base balance of the body. Some literature has linked pH to temperature [14]. Anything that disrupts the H^+ balance is capable of increasing or decreasing pH and such increase in temperature creates agitation in the cells and may increase H^+ which may cause significant decrease in pH (acidic) as a result of increasing H^+. Therefore, addition of sodium bicarbonate acts to buffer and balance the blood pH to neutral. The fluctuations in blood parameters could be as an act of buffering reaction going through the body. There is a likelihood that blood pH being lowered to acidic level could create room for growth and sustenance of disease causing microorganism and possible rise in oxidative stress which could increase the level of white blood cells as observed in the experiment, seeing that white blood cell count was highest in high energy diet (without buffering agent) at 5 and 6 weeks of age. The effect of the buffering agent was observed in diet 3 seeing that WBC counts were maintained even at 8 weeks of age. The results at 8 weeks showed that $NaHCO_3$ supplemented high energy diet had increased PCV, Hemoglobin concentration, red blood cell count and eosinophils. This fell in line with the reports of Khurhaid and Asim [15] who reported on the influence of heat stress and mineral on blood parameters. Their report further revealed that a combination of vitamin C and sodium bicarbonate increased erythrocyte and offered a good management practice to reduce heat stress.

Live-weight and dressed weight were not affected by high energy diets, but abdominal fat was affected leaving the birds in the control group with highest abdominal weight. Generation of internal heat through high energy feed can increase metabolic rate,

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increase digestion through increase in water intake which may reduce the absorption and storage of fat. In this study, dietary supplementation of $NaHCO_3$ influenced organ weight, which is in line with the results of Mirza *et al.,* [16] who reported that lowered abdominal fat and spleen weight were observed with supplementation of broiler feed with $NaHCO_3$ and Na_2SO_4 . Also Pourreze and Edriss [17] noticed that high temperatures decreased slaughter, carcass and abdominal fat weight and increased dressing percentage. This further explains that both high temperature and $NaHCO_3$ can affect abdominal fat. Kidney weight increased slightly across treatment group, although were not significantly different. The increase in kidney weight is also in line with the reports of Mirza *et al.,* [16]. This suggests that bicarbonate buffer system mainly determines blood acid-base balance for optimal production performance and functions under regulatory control of the kidneys [18]. Increase in kidney may mean an imbalance in acid-base regulation.

The crop pH across the treatment group were slightly acidic, although diet 3 with sodium bicarbonate was closer to neutral. The acidic environment of the crop is crucial to optimal efficacy of the exogenous enzymes added to the chicken diets. It is well-documented that bacterial or fungal enzymes show the highest activity at pH 4.0–6.0 [19;20]. In the situation where pH value is above 6.5 (up to 3 h after feeding) the enzymes activities are decreased to 10–15% of effectiveness at pH 4.5 or 5.5 [21]. Thus, the crop allows for a thorough utilization of exogenous enzymes by decreasing the pH value of digesta through the Lactobacilli fermentation. It should be noticed that disturbances of microbial composition may be a limiting factor for maximizing the enzyme activity. The bird crop is generally known to store up undigested food material for a short time before transfer to the stomach through the oesophagus, it also contains a fluid normally called crop milk which is capable of sustaining some enzymes which aid digestion due to its acidic nature. This result explains that heat stress increased crop pH and was further increased by sodium bicarbonate which can limit enzyme and microbial activities.

CONCLUSION

In conclusion, at temperatures between 28^{0}C-34^{0}C and under high energy diets, inclusion of $NaHCO_3$ did not affect live weight and dressed weight. Its inclusion decreased abdominal fat. It also increased erythrocyte, hemoglobin and PCV. The use of sodium bicarbonate suggests a good offer to good management in broiler production and in combating heat stress.

REFERENCES

[1] Nienabar, J. A. and Hahn, G. L. (2007) "Livestock production system management responses to thermal challenges" Publications from USDA-ARS/UNL Faculty.217. http://digitalcommons.unl.edu/usdaarsfacpub/217

[2] Deeb, N., and A. Cahaner. (2002). Genotype-by-environment inter-action with broiler genotypes differing in growth rate: 3.Growth rate, water consumption and meat yield of broiler progeny from weight-selected vs. non-selected parents under normal and high ambient temperatures. Poult. Sci. 81:293–301

[3] Sejian V., Indu S., and Naqvi S.M.K. (2013). Impact of short term exposure to different environmental temperature on the blood

ISSN: 0974 – 3987
IJBST (2018), 11(4):36-45

DOI: http://doi.org/10.5281/zenodo.1478578

biochemical and endocrine responses of Malpura ewes under semi-arid tropical environment. Indian J. Anim. Sci.;83(11):1155–1160.

[4] Srikandakumar A, Johnson E.H.(2004). Effect of heat stress on milk production, rectal temperature, respiratory rate and blood chemistry in Holstein, Jersey and Australian Milking Zebu cows. Trop. Anim. Health Prod.;36(7):685–692.

[5] Al-Haidary A.A. (2004) Physiological responses of Naimey sheep to heat stress challenge under semi-arid environments. Int. J. Agric. Biol. ;6(2):307–309.

[6] Ghazi S.H., Habibian M., Moeini M.M and Abdol mohammadi A.R. (2012). Effects of different levels of organic and inorganic chromium on growth performance and immunocompetence of broilers under heat stress. Biological Trace Element Research, 146: 309-317.

[7] Bartlett J.R and Smith M.O. (2003). Effects of different levels of zinc on the performance and immunocompetence of broilers under heat stress. Poultry Science, 82: 1580-1588.

[8] El Hadi H., Sykes A.H. (1982). Thermal panting and respiratory alkalosis in the laying hens. British Poultry Science 23:49-57.

[9] Lamberg, S, L. Rothestein, R. (1977). Laboratory Manual of hematology and urinanlysis.Avi.publishing company, inc. west povt. Connecticut, USSR

[10] SAS (2003). The referred proceedings of 10th International Symposium on statistical analysis, held in San Diego, CA, USA.

[11] Damron, D. L., Johnson W. L., and Kelly L. S. (1986). Utilization of sodium from sodium bicarbonate by broiler chicks. Poultry Sci. 65:782–785.

[12] Mirsalimi, S.M. and Julian, R.J. (1993).Effect of excess sodium bicarbonate on the blood volume and erythrocyte deformability of broiler chickens. Avian pathol. 22(3):495-507

[13] Albritton A.B. (1952). Standard Values in blood. Philadelphia, W.B. Saunders

[14] Hunkar O (2017). The effects of temperature on the pH of water. (Https//sceincing.com/effect-temperature-pH-water-6837207.html. Retrieved Nov, 24, 2017)

[15] Khurshaid A. and Asim A. (2013). Clinicopathological changes induced by heat stress, their resolution by minerals and vitamin C supplementation in quails. IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)e-ISSN: 2319-2380, p-ISSN: 2319-2372.Volume 5, Issue 1 PP 47-52 www.iosrjournals.org

[16] Mirza N, Marson A.G. and Pirmohamed M. (2009). Effect of topiramate on acid-base balance: extent, mechanism and effects. Br J Clin Pharmacol ;68:655-61.42.

[17] Pourreza J., and Edriss M.A. (1992). The effects of high vs. normal temperatures on the physical characteristics of the broilers carcass. J Agric Sci Technol. 1:35–41.

[18] Hooge D.M.(2003). Practicalities of using dietary sodium and potassium supplements to improve poultry performance. Proceedings of Arkansas Nutrition Conference. p. 19.

[19] Ademark P., Larsson M., Tjerneld F., Stålbr and H. (2001). Multiple α-galactosidases from Aspergillus niger: purification, characterization and substrate specificities. Enzyme Microb. Tech., 29: 441–448.

[20] Greiner R., Konietzny U. (2011). Phytases: Biochemistry, enzymology and characteristics relevant to animal feed use. In: Enzymes in farm animal nutrition, Bedford M.R., Partridge G.G. (eds). CAB Intl. Publishing, Oxfordshire, UK, pp. 96–128.

[21] Baas T., Thacker P. (1996). Impact of gastric pH on dietary enzyme activity and survivability in swine fed β-glucanase supplemented diets. Can. J. Anim. Sci., 76: 245–252.